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File Code: 3420 **Date:** November 12, 2004
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Subject: Southwestern Dwarf Mistletoe Infection of Ponderosa Pine in the Dye Thinning Project Area, Black Mesa RD (blackmesard)

To: District Ranger, Black Mesa Ranger District

On October 8th, I met with Gayle Richardson, Silviculturist, to view and discuss stand conditions in the Dye Thinning Project area. This letter describes the affected environment, general biology/ecology, and silviculture options relative to southwestern dwarf mistletoe infection of ponderosa pine in the 7 stands (approximately 600 acres) of the proposed project area. Site-level vegetation information was provided by Gayle and is based on stand exams.

During stand exams, each inventory tree is assigned a dwarf mistletoe rating (DMR) using Hawksworth's 6-class system[i]. This rating system divides the live crown of trees into thirds, and each third is rated separately as: 0, no mistletoe infection; 1, less than 50% of live branches infected; 2, more than 50% of live branches infected. The ratings for each third are totaled to obtain the DMR for a tree. Mean DMR for a stand is then calculated by adding the DMRs for all infected and uninfected live trees greater than 1 inch diameter at breast height (DBH), and dividing by the total number of trees.

Six stands are composed of pure ponderosa pine and the seventh is dominated by ponderosa pine with a mix of white fir and Douglas-fir. All sites are multi-storied and infected with southwestern dwarf mistletoe in nearly all size classes of ponderosa pine. Stand exam results report 1 stand having a moderate DMR rating of 0.8, while the rest are heavily infected with DMR ratings of 1.0 to 2.0. Since many stand exams are over 8 years old, DMR levels are expected to be greater than reported. In fact, although only one stand exam reported dwarf mistletoe infection in trees less than 7 inches DBH, Gayle and I observed infection of smaller size classes was common in most sites. We also observed abundant ponderosa pine seedlings that are not infected with dwarf mistletoe as they currently present too small a target.

Dwarf mistletoe infection levels are considered when prescribing silvicultural treatments due to effects of disease on the development of stands. Although some affects are beneficial, severe dwarf mistletoe infection causes mortality and growth loss of mature trees and limits the growth and survivability of regeneration.

Dwarf Mistletoe Biology/Ecology

Dwarf mistletoes are parasitic, seed-bearing plants that depend on their hosts almost completely for water and nutrients. They are natural components of many forest ecosystems in the West, causing significant changes in physiological processes and structural characteristics of infected trees, which result in changes in the structure and function of forest communities.[ii] [iii] Infected host trees are slowly weakened and eventually killed as dwarf mistletoe drains them of water and nutrients. Overall effects on forest structure in a site that has been infected for many generations include: increased stand openings; lower crown canopy; denser canopy due to witches' brooms; and fewer large diameter trees.

These impacts can provide forage for many species of birds[iv] and mammals[v]. Although many bird species have been observed feeding on mistletoe berries and shoots, there is little quantitative data on any except for blue grouse, which has been found to consume Douglas-fir dwarf mistletoe shoots in the fall. Insectivorous birds feed on insects that feed on the mistletoe shoots, fruits and seeds of dwarf mistletoe, and on bark beetles that attack trees weakened by dwarf mistletoes. Recent research has measured positive, negative, and null correlations between mistletoe related variables (e.g., the amount of mistletoe on a site and snag density) and bird species abundance in ponderosa pine sites in northern Arizona[vi]. Of the 16 bird species investigated, a positive relationship was found for 4 species, negative correlation for 5 species, and no correlation for 7 species. Three of the 4 species that were positively correlated with dwarf mistletoe infestation or snag density were cavity-nesting birds. The only foliage nesting bird with a positive relationship was western tanager. Bennetts[vii] found a positive correlation between mistletoe infection and 24 bird species; however, his Colorado study sites had a mixed-conifer and understory shrub component absent from Parker's study sites in Arizona.

Dwarf mistletoe infections can result in the formation of abnormal growth structures or branching patterns in the host known as witches' brooms. These structures are frequently used for foraging/caching, nesting, and roosting/resting sites by birds and mammals[viii]. Garnett[ix] found 23% of examined witches' brooms contained evidence of wildlife use, with Abert squirrels being the most common users.

Survival of an infected host is influenced by the severity of dwarf mistletoe infection and site factors. Hawksworth and Geils[x] determined 32-year survival rates of tagged ponderosa pines with various intensities of dwarf mistletoe infection at Grand Canyon National Park, AZ. While more than 90% of the uninfected and lightly infected trees survived the 32-year period, only 5% of the heavily infected trees over 9 in. dbh and none of those in the 4-9 in. dbh class survived. Heavily infected trees are frequently attacked by secondary bark beetles, which hasten their death.

Dwarf mistletoes have a fairly complicated and long life cycle. Seeds of dwarf mistletoes are explosively released and expelled to distances typically ranging from 10 to 40 feet. Infection takes place through the bark on needle-bearing portions of twigs. Dwarf mistletoes first produce an endophytic system, a specialized rootlike structure that is in contact with the phloem and xylem of host trees, from which the parasite obtains most of its nutrients and water. Aerial shoots appear between 2 to 5 years after infection; fruit development occurs two to three years later. The period of infection before shoots are visible is known as the latent period.

Spread of dwarf mistletoe is a function of stand structure, density, age, and site index. Spread from overstory to understory is the most rapid, because it is multidimensional. Initially, all infections in the young stand develop directly from seeds produced from overstory trees. Then there is a period when infections in the young stand begin to produce seeds that further infect the stand. Subsequently, infection in the young stand progresses outward beyond the range of the seeds produced in the overstory stand. Spread through even-aged stands is termed lateral spread.

Researchers[xi] [xii] measured the distance of infected seedlings from the source of overstory trees at different time intervals. In 20-year-old stands, nearly all infection was found to be attributable to seed produced in the overstory with 80 percent of infected seedlings within 35 feet of the infected overstory trees. In 50-year-old stands, lateral spread accounted for about one-half of the spread in open stands and one-third of the total in dense stands, with distances from the original overstory seed source reaching nearly 80 feet and 65 feet, respectively.

Wildfires are one of the primary ecological factors in determining the distribution and intensity of dwarf mistletoes in unmanaged coniferous forests. During wildfires, relatively complete burns tend to have a sanitizing effect on dwarf mistletoe infected stands if all susceptible trees are killed. However, partial burns can lead to rapid infection of regeneration, if scattered infected trees remain over newly established regeneration. Prescribed burns tend to reduce infection levels. Heavily infected trees have reduced survival rates compared to lightly infected or non-infected trees[xiii] [xiv]. Infected limbs located in the lower crowns of trees are also killed back during prescribed burns.

Proposed Prescriptions

The impacts of dwarf mistletoe infection used to be based on single variables relating to timber production, such as wood volume or basal area. Disease effects are now assessed on those and other resource values including wildlife and recreation. Silvicultural prescriptions are selected to reduce the impact dwarf mistletoe infection has on achieving resource objectives. However, the greater the infection level, the fewer treatment options available. Lightly to moderately infected stands can be thinned, depending on the age and structure of the stand, without impacts to timber or wildlife resources. Even-aged stand conditions are often advised in timber producing blackjack (vegetative structural stage 3 (VSS3)) areas in order to slow the spread of disease (i.e., mistletoe spreads more slowly on trees growing on good quality sites). Where wildlife is emphasized and growth impacts are not a major concern, more mistletoe infection may be tolerated. Multi-storied stands with heavy infection levels are either regenerated or deferred, depending on management objectives and disease intensity across the landscape.

The main objective of the Dye Thinning Project is to improve the growth and vigor of trees. Since heavily dwarf mistletoe infected sites were found to have adequate newly established clean regeneration, Gayle and I would like to emphasize this age class in many areas by removing neighboring diseased trees. This project can create seedling structure (VSS1), which is deficient throughout the surrounding forest. Leaving heavily diseased trees to infect seedlings would result in a future forest with a lower crown canopy, denser canopy due to witches' brooms, and few large diameter trees.

There are other stands outside the project boundaries which will still provide such dense structure. Areas of the Dye Thinning Project that have lower infection levels and where protecting regeneration is not a concern will be thinned with the emphasis on removing the more heavily dwarf mistletoe infected trees. Non-host tree species will be selected as leave trees where they occur.

/s/ Mary Lou Fairweather
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cc: Gayle Richardson, John Anhold, Debra Allen-Reid

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